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TOOTHBRUSH

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention pertains to a toothbrush with excellent ability to clean interdental spaces and a cervical portion of a tooth, and excellent ability to clean smooth surfaces, such as the tooth surface, etc.

2. Description of the Related Art

A toothbrush cleans, that is, brushes, teeth inside the oral cavity using the resiliency of the monofilaments of the tufts implanted in the tufting holes of the handle. Since the cleaning results increase with an increase in resiliency, there is a demand for a toothbrush with high resiliency, basically in the direction of brushing. Moreover, there is also a need for a toothbrush that can adapt to the state of the site to be cleaned in order to manifest cleaning activity specific for each individual site. There are various types of cleaning capabilities in response to the state of the site to be cleaned, but typical examples are the ability to clean the tooth surface, which is a smooth surface, and the ability to clean the tight spaces of the tooth. The tight spaces include the interdental spaces and the cervical portion of the tooth, as well as the occlusal surfaces, etc., and of these, food residue and plaque easily accumulate in the interdental space, which is an interproximal site. This

is often a cause of caries and periodontal disease. Therefore, the ability to clean interdental space is particularly important. Thus, there is the general problem of improving the resiliency of a toothbrush, and at the same time, there is the problem of improving interdental cleaning activity while retaining smooth surface cleaning activity, and a toothbrush that can solve these problems is needed.

The toothbrush disclosed by the present applicant with a publication of unexamined application No. 9-149815 is an example of that was developed in line with this purpose. This toothbrush is characterized in that of the tufts comprising the tufting part, one or more tufts has an almost elliptic cross section, which spreads out in width in the direction of handle length, with their end portions converge in the shape of a roof. There is a major advantage to this type of tuft in that the extent to which the filaments aggregate together varies with their direction and therefore, tuft stiffness changes with the direction in which the tufts are pressed and thus, it is possible to improve smooth surface cleaning performance by making the direction of strong stiffness the same as the brushing direction, and at the same time, since the end portions of the tuft converge together, the ability to be inserted to the tight spaces, such as the interdental space, is also excellent.

On the other hand, the structure whereby adjacent fibers are inclined so that they support one another and the tufts touch at their end portions to make a part where the tufts converge together is a special technique for improving insertion of tufts into interdental space. This tuft converging part has high density and a strong tuft stiffness, and the tufts are not loose bundles. Consequently, there is an advantage in that by designing the toothbrush so that the direction in which the tufts support one another corresponds to the brushing direction, a toothbrush is obtained that has excellent capability of being inserted into tight spaces, such as interdental space and a cervical portion of the tooth, and improved capability of cleaning these places.

Attempts are also being made to increase resiliency of the monofilaments as a different means relating to this type of tuft concept.

General countermeasures for increasing resiliency of the monofilament are increasing the diameter of monofilaments with a round cross section or using a harder material for the monofilament, but improving cleaning performance by these countermeasures only can hardly be expected. The reason for this is that when the diameter of the monofilament is increased or a harder material is used for the monofilaments, it will feel as if there is too much irritation of the tissues inside the oral cavity by contact

with the monofilaments, and there are also cases where the bristle end portions will not reach into the tight spaces between the teeth when only these measures are taken.

Incidentally, when discussing the cleaning power of a toothbrush, it is necessary to also consider the relationship with the brushing method. The scrubbing method whereby the handle is moved back and forth, little by little, in the lengthwise direction to clean the tooth has recently become the main brushing method, replacing the old rolling method whereby the handle is rolled in the direction of width to clean the tooth. Therefore, improvement of cleaning power should be considered focusing on the scrubbing method.

There is a demand for a toothbrush with improved cleaning activity and excellent smooth-surface cleaning performance and tight-space cleaning performance that is suitable for brushing by the scrubbing method, but good appearance and durability as a toothbrush while having excellent cleaning capability cannot be disregarded. For instance, it is important that the monofilaments be uniformly distributed over the tufting holes so that they give a beautiful raised appearance to the toothbrush, while the toothbrush must be durable enough that the end portions of the tufts will not spread out (so-called "permanent set in fatigue") and the tufting base will not crack or break during the course of use of the toothbrush.

SUMMARY OF THE INVENTION

The toothbrush of the present invention is characterized in that the tufting holes formed in the tufting part are almost elliptic or almost rectangular and these tufting holes are inclined toward the tufting surface.

As in the past, the tufts are fixed in the tufting holes using an anchor. However, in the present toothbrush, the tufting holes are almost elliptic or almost rectangular and are inclined toward the tufting and therefore, the tufts that have been embedded become tufts with an almost elliptic or almost rectangular cross section that are inclined toward the tufting surface.

Since the inclination of the tufts is due to the inclination of the tufting holes themselves, the inclined state is retained, even after repeated use [of the toothbrush].

In addition, the tufting holes are almost elliptic or almost rectangular and the number of filaments that are clustered together to form the tufts differs in the direction of greater width of the tufts and in the direction of narrower width of the tufts and therefore, tuft stiffness is different depending on the direction. Consequently, by designing the lengthwise direction of the tufting holes taking the brushing method into consideration, it is possible to obtain good tuft stiffness

and realize superior cleaning activity. The term tuft stiffness used here is the property that is realized from the extent of resiliency (restitutive force) that comes into play when pressure is applied and the tuft deforms.

Moreover, a converging part with high resiliency is formed at the end portion in an converging block of tufts that is formed when the inclined tufts themselves support one another. This end portion part can be easily inserted into tight spaces such as interdental space and a cervical portion of the tooth, etc., and therefore, these spaces can be firmly brushed by the inserted tufts.

When the tufting holes are almost rectangular, the contact resistance when the tufts first touch the tooth can be minimized because the tufts are streamlined.

The direction of the tufting holes that are almost elliptic or almost rectangular is determined in accordance with the brushing procedure. For example, the lengthwise direction of the tufting holes is along the direction of handle length by the scrubbing method or the Bass method that is mainly back-and-forth movement in the direction of handle length. The term "along the direction of handle length" here includes both the state of being parallel to the direction of handle length and the state of slight inclination to the direction of handle length.

When the lengthwise direction of the tufting holes is along the direction of handle length, resiliency of the

monofilaments in the brushing direction can be increased when teeth are being brushed by the scrubbing method. Consequently, monofilament resiliency can be increased and as a result, the teeth can be thoroughly polished by this resiliency and cleaning activity can be improved when the handle is moved back and forth, little by little, in the lengthwise direction.

In particular, when the tufting holes that are formed along the direction of handle length are almost elliptic, both ends of the tuft in the direction of handle length form a curved, narrow peak and therefore, the monofilaments can easily penetrate interdental space, improving cleaning activity even further, when teeth are brushed by the scrubbing method.

It is preferred that the tufting holes be inclined toward the inside, facing one another, to make tufts that form pairs and that there be at least one of these tuft pairs.

Inclination toward the vertical direction of the tufting holes should be set within a range of 2 to 10°.

The monofilaments comprising the tufts embedded in the tufting holes can also have a round cross section, but a rectangular cross section is preferred. When monofilaments with a rectangular cross section are used and are embedded with the lengthwise direction of the cross section of the monofilament, that is, the long side, being in the

lengthwise direction of the tufting holes, resiliency of the monofilament when brushing is performed by the scrubbing method can be further improved. Moreover, the irritation that is felt in the oral cavity is related to the cross sectional area of the monofilament. The irritation can be reduced when the cross sectional area of the monofilaments is small. When monofilaments with a round cross section and monofilaments with a rectangular cross section are compared, the cross sectional area needed to obtain the same resiliency is smaller with monofilaments with a rectangular cross section and therefore, irritation of oral cavity tissues can be reduced with a toothbrush that uses monofilaments having a rectangular cross section.

It is preferred that the tufts that are embedded in the inclined tufting holes form a pair of converging blocks where two tufts facing one another lean against one another and that there be several of these converging blocks.

The end portion of each tuft should be worked into a V-shape in order to improve tight-space cleaning performance.

By making the end portion into a V-shape, tight-space cleaning performance can be further improved. In particular, when is a V-shape so that an inclined face is formed on both sides perpendicular to the direction in which adjacent tufts support one another, tight-space cleaning performance in the direction of handle length and

tight-space cleaning performance in the direction of handle width can be improved. Moreover, the number of filaments per each tuft that comprises the V-shape is more than conventional toothbrushes where 1 V-shape is formed from 2 tufts, and tuft resiliency is very strong.

The number and arrangement of converging blocks that form a pair and are made with the tufts supporting one another can be selected as needed, but it is preferred that there at least be a converging block at the front end or the back end in the direction of handle length.

It is preferred that the next row of converging blocks be behind the space that is formed between the converging blocks in the previous row in the direction of handle length. When this is the case, areas that were missed by the converging block in the previous row will be brushed by the next row of converging blocks and therefore, a smooth surface, such as a tooth surface, etc., will be brushed over its entire area by the end portion of a stiff converging block having excellent brushing power.

Tufts are folded in the middle in a lengthwise direction and then embedded in the tufting holes with an anchor that is as long as the cross section of this fold, and the tufts are thereby fixed and supported in the tufting holes. When the tufts are fixed in the tufting holes with this type of anchor, the anchor is driven into the tufting hole so that the opening surface area of the

tufting hole is divided into two equal parts, being almost parallel to the long or the short side of the tufting hole. Thus, it is possible to pack filaments into each area delineated by the anchor uniformly and prevent the tufts from falling out, which is caused by a packing density that is too loose, and obtain a beautiful embedded appearance.

If the anchor is to be almost parallel to the tufting holes in their lengthwise direction, the anchor should be within $\pm$ 10° to the center line along the lengthwise direction of the above-mentioned tufting holes.

Incidentally, when the anchors are driven [into tufting holes] in this position, they will be in almost a straight line [on the tufting base] and as a result, there is a strong chance that cracks will be made starting where the anchor is driven [into the hole]. In order to prevent this from occurring, the tufting holes can be made so that the centers of the tufting holes do not form a straight line in the direction of handle length.

The tufting holes should account for 10 to 30 mm in the direction of handle length and 5 to 15 mm in the direction of handle width. By specifying how much space on the handle is occupied by tufting holes, it is possible to eventually specify the tuft brushing area. If the area occupied by the tufting holes is within the above-mentioned range, there will be an increase in the smooth surface, such as anterior teeth, etc., that can be efficiently

brushed without any reduction in maneuverability inside the oral cavity.

If the tufting holes are almost rectangular holes, the short side of the tufting holes should be 0.8 to 2.0 mm and the long side of the tufting holes should be 1.5 to 5.0 mm. If the dimensions of one tufting hole are within this range, the size of the end portion of the converging part that is made when adjacent tufts support one another is optimal for realizing both smooth-surface cleaning performance and tight-space cleaning performance.

The distance between the base of the pair of tufts that form a converging block should be within a range of 0.2 to 4.0 mm. By designing the angle of inclination of the tufts comprising the converging block to within a range of 2 to 10°, as previously explained, and setting the distance between the base of the pair of tufts that form the converging block at 0.2 to 4.0 mm, it is possible to prevent the converging shape from collapsing, even with long-term use.

Moreover, a toothbrush will be considered as an actual toothbrush obtained in this way where there are 5 rows of tufts in the lengthwise direction of the tufting base, with Rows 1 and 5 forming one converging block in the center in the direction of width of the tufting base, Rows 2 and 4 forming 2 converging blocks on either side sandwiching the center in the direction of width of the tufting base, and

Row 3 forming one converging block at the center in the direction of width of the converging block, and there is 1 independent tuft, each inclined so that it is in the same direction as the tufts that form the above-mentioned converging blocks, but its end portion does not touch the converging blocks, to the outside of the above-mentioned converging blocks.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is a plane view showing the entire structure of the toothbrush of the present invention, Figure 2 is an oblique view showing the tufting part of a typical example of the present invention, Figure 3 is a plane view of the same tufting part, Figure 4 is a left view showing the same tufting part from the front end, Figure 6 is a plane view showing the shape and arrangement of the tufting holes made in the tufting base, Figure 7 is the I-I cross section in Figure 6, Figure 8 is the II-II cross section in Figure 6, Figure 9 is the III-III cross section in Figure 6, Figure 10 is a IV-IV cross section in Figure 6, Figure 11 is the V-V cross section in Figure 6, Figure 12 is the anchor driven into the tufting holes and is a diagram explaining how the holes into which this anchor is driven are arranged, Figure 13 is a diagram that shows the anchor driven into the tufting holes and describes how the holes into which this anchor is driven are arranged, Figure 14 is a diagram showing the anchor driven into the tufting

holes in a conventional toothbrush and explains how the tufting holes into which this anchor have been driven are arranged, Figure 15 is a diagram representing a V-shaped tuft end portion, Figure 16 is a different type of V-shape, Figure 17 is a different type of V-shape, Figure 18 is a different type of V-shape, Figure 19 is a diagram showing the rows of teeth, Figure 20 is a diagram explaining how the tufting part comes into contact with the anterior surface of the rows of teeth, Figure 21 is a diagram showing the pattern of brushing the tooth surface and the cervical portion of the tooth, Figure 22 is a diagram showing the pattern of brushing a molar, Figure 23 is a diagram explaining how molar teeth are cleaned in succession by the tuft rows, Figure 24 shows other types of tuft rows, Figure 25 is a diagram showing where smooth-surface cleaning capability and tight-space cleaning performance are evaluated, Figure 26 is a graph showing the overall evaluation of smooth-surface cleaning performance and interproximal-surface cleaning performance, Figure 27 is a graph showing evaluation of interproximal cleaning capability, Figure 28 is a graph showing evaluation of smooth-surface cleaning performance, Figure 30 is a cross section of the tufting part in a second example where monofilaments with a rectangular cross section have been implanted in tufting holes that are almost elliptic, Figure 31 is a plane view of the tufting part when the number of

tufting holes and their arrangement was changed in the same example, Figure 32 is a diagram showing rectangular tufting holes in which monofilaments with a round cross section have been implanted, Figure 33 is a diagram showing elliptic tufting holes in which monofilaments with a rectangular cross section have been implanted, Figure 34 is a diagram showing oval-shaped tufting holes in which monofilaments with a rectangular cross section have been implanted, Figure 35 is a diagram showing the flow of molten synthetic resin when rectangular tufting holes are molded, and Figure 36 is a diagram showing the flow of molten synthetic resin when elliptic tufting holes are molded.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will now be explained with examples that illustrate its details. Unless otherwise indicated, lengthwise direction in the following description means the direction of handle length and direction of width means the direction of handle width. The direction of handle length is the same as the direction of tufting base length and the direction of handle width is the same as the direction of tufting base width.

Figure 1 shows the handle before the tufts have been implanted. The toothbrush of the present invention is characterized by the state of the tufting part shown by A

in the figure, and neck B and grip C can have any shape. The structure of tufting part A is explained below.

The toothbrush of the present invention is characterized in that the openings for the tufting holes formed in the tufting part are almost elliptic or almost rectangular and the holes are inclined toward the tufting surface. What is important here is that the tufting holes are almost elliptic or almost rectangular and as a result, there is a difference in resiliency during brushing in the direction of length and the direction of width of the tufting holes and strong resiliency is obtained in the direction of length of the tufting holes. Furthermore, in addition to this, the tufting holes are inclined and the end portions of the tufts that have been implanted in these tufting holes converge in the direction of inclination, improving the capability to clean tight spaces (referred to below as tight-space cleaning capability).

The tufts implanted in the tufting holes are made from bundles of monofilaments. There are no restrictions to the cross section of the monofilaments. Monofilaments with a round cross section that are normally used can be employed, or the monofilaments with a rectangular cross section that are described later can be employed. If monofilaments with a rectangular cross section are used, resiliency of the monofilament in the lengthwise direction of their cross section will be increased. Moreover, since the cross

sectional area needed to obtain the same resiliency is less than monofilaments with a round cross section, irritation of the tissues inside the oral cavity is alleviated. Examples of the toothbrush of the present invention will now be explained. The first example describes the present invention using monofilaments with a round cross section implanted in rectangular tufting holes and then the next example describes the present invention using monofilaments with a round cross section implanted in elliptic tufting holes.

[Example of implanting monofilaments with a round cross section in rectangular tufting holes]

Figure 2 shows the appearance of a tufting part of a typical example, Figure 3 is a plane view of the tufting part, Figure 4 is a front view, and Figure 5 is a side view of the tufting part as seen from the front end. By means of this example, the tufting holes are rectangular and monofilaments with a round cross section are used.

Tufts 11, 12, 21 to 24, 31 to 34, 41 to 44, 51 and 53 52 are arranged in 5 rows in the lengthwise direction in tufting part A and there is at most 1 row of tufts in the direction of width. Moreover, the vertical cross section of the tufting holes in which these tufts have been planted is represented by attaching an "a" to the symbols for the corresponding tuft.

Each tuft is implanted in the direction of handle length from rectangular tufting holes with their long sides matching. Adjacent tufts that face one another are inclined inward in the direction of width of tufting base 1 so that a pair of tufts facing one another forms a unit and a block of tufts that converge at the end portions (referred to a converging block R) is made. There are several of these converging blocks R. The converging blocks R are spaced so that these converging blocks R are alternately formed at the front row and the back row in order to uniformly clean the entire tooth surface, which is a smooth surface, when the tooth is brushed by moving the handle back and forth in the lengthwise direction. Moreover, tufts 32 and 33 are inclined inward toward one another at the center row of the handle in its lengthwise direction and tufts 31 and 34 that are on the outside form isolated tufts.

Here, tufts 31 and 34 are inclined toward the inside somewhat, but they can also be standing straight up.

In addition, distance W between adjacent converging blocks R and R in the direction of width of the tufting base is somewhat narrower than the average width of a tooth, and when brushing is performed by moving the handle back and forth in the lengthwise direction, the tooth that is to be cleaned is thereby sandwiched between converging

blocks R and the surface on both sides of the tooth can be thoroughly cleaned.

Inclination of the tufts is accomplished by inclining the tufting hole itself and then pressing and fixing the tufts in the inclined tufting hole using an anchor. As a result of inclining the tufting hole itself, the inclined position of the tuft can be firmly maintained, even if force that would collapse the inclined tuft is repeatedly applied during brushing.

Figures 6 through 11 show the inclined state of the tufting holes. Figure 6 shows how the tufting holes are arranged in tufting base 1, and Figures 7 through 11 show the cross section of each of 5 rows that are made in the lengthwise direction of the tufting base.

The angle of inclination of the tufting holes should be based on tuft stiffness that is to be obtained, but it is usually set within a range of 2 to 10° with respect to the vertical direction of the inclined holes. The bristles must be extremely long for the end portion of the tufts facing each other to come into contact if the inclination is less than 2°, which is undesirable. On the other hand, an inclination greater than 10° makes handle molding difficult. The distance at the base between the tufts that form converging blocks R should be within a range of 0.2 to 40 mm. If inclination and the distance are set at the above-mentioned values, it will be possible to realize

sufficient durability to the pressure that is repeatedly applied during the course of use of the toothbrush and the converging shape of the tufts can be retained for a long period of time.

The angle of inclination of the tufting holes can vary with the position at which converging block R is formed, or it can be the same as in the present example.

The ability to penetrate the tight interdental spaces can be improved further by making the end portion of the tufts into a V-shape with an inclined face along the long side of the tufting holes. When an end portion with a sharp V-shape is employed, the ability of the toothbrush to brush out plaque and food sediment that has penetrated tight spaces is improved.

The dimensions of rectangular tufting holes are a short side S of 0.8 to 2.0 mm and a long side L of 1.5 to 5.0 mm, as shown in Figure 2. The surface pressure applied directly to the tooth surface is dependent on the shape of the end portion of the tuft, but if the dimensions of the tufting holes are smaller than the above-mentioned range, insufficient force will be transmitted to the end portions of the tufts.

The reason for using rectangular holes as the tufting holes is that good stiffness in accordance with the brushing direction can be obtained when there is a difference in the number of filaments clustered together

depending on the direction and as a result, resiliency, that is, stiffness, when pressure is applied to the tuft is given directivity. By using the embodiment where the long side of the tufting holes are along the direction of handle length, good stiffness is obtained when brushing is performed mainly by moving back-and-forth in the direction of handle length.

The space occupied by the tufting holes is set at 10 to 30 mm in the direction of handle length and 5 to 15 mm in the direction of handle width. If the tufting holes account for less than this amount of space, the tooth surface contact area will be small and there will be a reduction in cleaning efficiency.

The tufts are fixed in the tufting holes by driving an anchor into the hole as with conventional toothbrushes. The anchor is a 1.6 mm x 0.22 mm metal strip. This strip is sandwiched with a tuft that has been folded into a U shape and driven into the tufting hole with the tuft and both ends of the anchor in its lengthwise direction are wedged into the wall around the tufting hole to fix the tuft in the tufting hole. Conventional toothbrushes have round tufting holes and therefore, as shown in Figure 14, the anchor is driven into the tufting hole along its diameter, but by means of the present invention, anchor P is driven into the tufting hole so that it is parallel to the long side of tufting hole H and so that it divides the

opening surface area of the tufting hole into two equal parts, H1 and H2. Moreover, there is a possibility that cracking will increase if anchors P that have been driven into the tufting holes are in a straight line on the tufting base, but this can be prevented by staggering the position where the tufting holes are formed slightly in the direction of width.

By driving the anchor in exactly so that the opening surface area of the tufting hole is divided into two equal parts, there will be no bias to the number of filaments held in parts H1 and H2, which are delineated by anchor P, and there will be a marked reduction in the number of tufts that come loose. Moreover, a state can be realized where the filaments are uniformly filled in the tufting holes and therefore, the appearance after tufting will be beautiful.

Working the end portion of the tuft into a V-shape was previously discussed. Figure 15 represents the end portion of a tuft that has been worked into a V-shape. In this example, inclined faces r and r along the peak are in the direction of width of the tuft. The present example is also characterized in that an angular peak is made by 1 tuft. Slopes r and r toward the angular peak intersect in the direction in which the tufts support one another so that inclined faces of a V-shape are obtained. As a result, in addition to obtaining converging tufts where the tufts support one another, the end portions are squeezed in

the direction in which they intersect the above-mentioned direction of convergence from the V-shape and as a result, the end portions can be inserted into tight spaces when used for brushing by moving the handle up and down or to the left and right, and a sharp, stiff end portion is realized, making it possible to efficiently remove food sediment and plaque.

Although not illustrated, the slope toward the angular peak can also be formed in the direction in which the tufts support one another. This shape can be any shape as long as it falls under the category of V-shaped.

For example, the embodiment in Figure 16 where the front and back faces in the direction in which the tufts support one another are the inclined faces that form trapezoidal inclined face r1, the embodiment in Figure 17 where an isosceles triangle-shaped inclined face r2 is formed, the embodiment in Figure 18 where a right triangle-shaped inclined face r3 is formed, etc., can be used.

The structure of a first example, which is a typical example, was discussed, and the effects of the toothbrush of this example will now be discussed.

The toothbrush of the present invention is excellent in terms of its cleaning activity on smooth surface Z1, and it has excellent cleaning activity for interdental site A2, which is the part between adjacent teeth, occlusal surface Z3 of a molar tooth, etc., and a cervical portion of the

tooth Z4 shown by Figures 20 and 21. However, particularly good cleaning activity that should be emphasized is realized at interdental part Z2.

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For example, cleaning of the tooth surface with the toothbrush of the present example is shown in Figure 20. As shown by this figure, there is space SP between converging blocks R and R comprising each row of the tufting part, and the next row of converging blocks R is in the position of the next row, which is behind space SP. Consequently, when brushing is performed by moving the handle back and forth in the direction of the arrows in the figure, the teeth missed by the front row of tufts will be brushed by the next row of tufts and even if the tooth brush is moved up and down in the direction of handle width, the entire tooth surface can be effectively cleaned leaving any of the tooth surface unbrushed. Moreover, since these surfaces are being brushed by the stiff end portion of the converging block, cleaning power is excellent. When the toothbrush is pressed on the tooth surface, deforming force is applied to the tufts, but the converging block has tufts facing one another that support their inclined position and reinforce their shape and therefore, even if they are deformed, the tufts can recover and there will be no early reduction in brushing performance during the use of the toothbrush.

Moreover, Figure 21 shows cervical surface Z4 being cleaned. Food sediment and plaque that have deposited on the cervical portion of the tooth can be effectively brushed away because the end portion where the converging block converges is pushed into the cervical portion of the tooth, as shown in the figure.

Moreover, interdental space Z2 can be cleaned by moving the toothbrush up and down, but it is also possible to perform this back and forth movement so that the length of the handle is along the direction of the tooth row or is perpendicular to the direction of the tooth row. In the former case, using a tuft end portion that has a V-shape is very effective for improving the ability to insert the tuft end portion into interdental spaces.

On the other hand, in the latter case, the end portion of the tuft can be inserted between the teeth and the sediment between the teeth wiped away because the end portion of the tufts that support one another converge.

Figure 22 is a figure showing occlusal surface Z3 of a molar being brushed with the third row of tufts on the tufting base. In this case, the tuft end portion where converging block R, which is made from 2 tufts supporting one another on the inside, converges is inserted deep into the grooves formed in occlusal surface Z3 and the sediment on occlusal surface Z3 is wiped away with the stiff end portion, while the two tufts to the outside enclose around

the molar and brush off both sides of the molar. Brushing of occlusal surface Z3 has been explained here using an example where there is a third row for realizing the best cleaning effects, but it is also possible to realize good insertion of other rows of tufts into the occlusal surface even if the effects are slightly different.

The toothbrush of the present example has the following characteristic cleaning effects. For instance, taking into consideration the case where molars, etc., are to be brushed, the mechanism shown in Figure 23 comes into play. For instance, when an occlusal surface is brushed along the row of teeth, the molar is first touched by converging block R1 of the first row at the first position shown by P1 in the figure and the front surface in the forward direction is cleaned. Once the occlusal surface has been cleaned by converging block R1, which has run up onto the occlusal surface, the second row of tufts moves to second position P2 shown by the imaginary line in the figure as it is pushed to either side of the molar to be cleaned. In this position, the molar to be cleaned is enclosed by tufts and the front surface in the forward direction is cleaned by the converging block R3 in the center of row 3, while the sides are cleaned by the second row of tufts, which are pushed to either side in the direction of handle width. The same effect is obtained

moving to next third position P3 and as a result, the molar in question is thoroughly cleaned.

By means of the present example, the second, third and fourth row of tufts comprising the tufting part have a structure where there are 2 pairs of converging blocks, or there is one pair of converging blocks in the center and there is one tuft inclined slightly to the inside on either side. However, the structure of the rows of tufts is not limited to this example. For instance, as shown in Figure 24(a), the structure of some of each row of tufts can be such that the tufts on both sides of the row are inclined to the outside, as shown in Figure 24(a), or such that there are no converging blocks and all 4 tufts are inclined to the outside, as shown in Figure 24(b).

The present inventors confirmed the cleaning effects of the toothbrush of the present example by comparison with a conventional toothbrush using a dental study model to study smooth-surface cleaning performance and tight-space cleaning performance.

A toothbrush with the tufting pattern shown in Figure 2 (this is referred to below as Trial Product 1) was used as the toothbrush representing the present invention in the comparisons, while popular commercial toothbrushes were used as the object of comparison. Commercial products A and B were employed as the toothbrushes to be compared (referred to be low as comparative product). Comparative

product A had almost rectangular tufting holes and a V-shape formed by two tufts. Moreover, Comparative Product B had almost rectangular tufting holes and tuft pattern of steps of tufts with different lengths for each tufting hole in the direction of handle length.

The lower right first molar was selected as the site for comparison of cleaning activity. Although tight-space cleaning performance means the ability to clean indentations, such as spaces between the teeth, the cervical portion of the tooth, an occlusal surface, etc., only interproximal-surface cleaning performance, which is the ability to clean the interdental space, was evaluated. The test method and test results are described below:

First, spray for checking for dental occlusion (brand name "Occlude," Pascal Co., Ltd.) was applied to the dental study model and then the buccal surface of the molar of the dental study model in a state of top and bottom occlusion was brushed using the sample toothbrush and a brushing simulator. Brushing was performed with the direction of handle length along the row of teeth (almost parallel) and the toothbrush being moved back and forth in the direction of handle length. Brushing conditions were set at a weight in a stationary state of 250 g, brushing time of 6 seconds, amplitude of 10 mm, brushing speed of 37 mm / second, and 1 stroke time being 0.225 second.

Once the front teeth were brushed under these conditions, performance in terms of cleaning the lower right first molar, which was the site of the test, was evaluated. As shown in Figure 25, 70% of the above-mentioned molar surface was "smooth surface" (shown by F in the figure) and 15% on each side of the "smooth surface" was "interproximal surface" (shown by K in the figure), and cleaning performance of both types of surfaces was evaluated. Cleaning performance is represented by percent and is the value obtained by subtracting "uncleaned surface area after cleaning test" from "uncleaned surface area before cleaning test" and then dividing this by "uncleaned surface area before cleaning test." The results are shown in Figures 1 and 2 and the mean values are plotted in Figures 26, 27 and 28.

(Table 1)

Interproximal cleaning performance

	Trial product 1	Comparative Product A	Comparative Product B
1	54.5	36.5	46.1
2	50.5	26.3	41.1
3	58.5	35.5	43.6
Mean value	54.5	32.8	43.6

(Table 2)

Smooth-surface cleaning performance

	Trial product 1	Comparative Product A	Comparative Product B
1	84.8	64.6	59.5
2	88.0	66.7	73.3
3	81.6	62.4	58.7
Mean value	84.8	64.6	63.8

As is clear from the above-mentioned results, in contrast to the fact that interproximal cleaning performance was 32.8% for Comparative Product A and 43.6% for Comparative Product B, the Trial Product of the example of the present invention reached a high cleaning performance of 54.5%, and in contrast to the fact that smooth-surface cleaning performance of Comparative Product A was 64.6% and that of Comparative Product B was 63.8%, the trial product of the example of the present invention reached a high cleaning performance of 84.8%. Only interproximal cleaning performance was evaluated in the evaluations of tight-space cleaning performance, but it is estimated that the same excellent results obtained for interdental space would be obtained in terms of the cleaning activity on the cervical surface and occlusal parts of the teeth.

A dental study model was used for the above-mentioned comparative study, but the inventors also performed clinical trials using the above-mentioned Trial Product and

the above-mentioned Comparative Product A at a university school of dentistry in order to confirm in detail the effects when actually used on the oral cavity. By means of this test method, 21 subjects were obligated to brush their teeth two or more times a day for 7 days and the amount of plaque before and after brushing was measured and plaque removal efficiency by brushing was evaluated.

Six teeth were selected as typical teeth within the oral cavity in evaluations of plaque and the tooth to be studied was stained with a plaque stain and height to which the plaque was deposited was measured at 6 places on 1 tooth in units of 0.5 mm. The results are listed in Table 3.

Table 3

	Number n	Trial product 1		Comparative Product A		Difference between groups (p value)	Significant difference ($p < 0.05$)
		Average	SD	Average	SD		
Entire tooth	21	63.1	19.5	50.5	17.0	0.00179	○
Upper jaw	21	61.6	22.0	47.4	19.3	0.00395	○
Lower jaw	21	63.3	20.5	55.1	23.2	0.06558	×
Buccal side	21	72.4	20.3	56.3	20.8	0.00214	○
Lingual side	21	53.7	22.3	42.9	18.9	0.01373	○
Center	21	72.7	19.3	57.1	25.4	0.00562	○
Adjacent	21	59.1	20.3	48.5	15.4	0.00919	○

SD = Significant difference

The difference between groups was studied by paired t tests.

As shown in Table 3, the Trial Product of the present invention provided better results than Comparative Product A for all parts studied. Moreover, it was confirmed that the difference between the toothbrushes was significant (level of significance $P < 0.05$) for all parts studied except the lower jaw.

[Example of implanting monofilaments with a rectangular cross section into elliptic tufting holes]

Next, the inventors made a toothbrush where monofilaments with a rectangular cross section were implanted in tufting holes with an elliptic opening inclined toward the tufting surface and studied this toothbrush. The tufting part of this toothbrush is shown in Figure 30. This toothbrush has 1 tufting hole 100, two tufting holes 110 and 120, and three tufting holes 130, 140 and 150 from the end portion side in the direction of length of the tufting base. Tufting hole 100 at the end portion and tufting hole 140 in the middle of the 3 tufting holes at the back are perpendicular holes, while 2 tufting holes 110 and 120 of the second row face inside (toward the center of the tufting base), inclined at an angle of 3°, and tufting holes 130 and 150, on either side of above-mentioned tufting hole 140 in the middle at the back end

are each inclined at an angle of 3° toward the inside and monofilaments with a rectangular cross section are tufted in these tufting holes. The small rectangular cluster in each tufting hole is a cluster of monofilaments and an anchor is seen intersecting along the lengthwise direction in the center in the direction of width of each tufting hole. By placing the tufts at either side in the direction of tufting base width so that they are inclined toward the inside with this toothbrush, it is possible to prevent the filaments from separating to the outside in the direction of tufting base width when teeth are brushed by moving the handle back and forth in its lengthwise direction and a reduction in resiliency that occurs when the filaments separate to the outside can thereby be prevented. This is an example of a toothbrush where the number of tufting holes is relatively few and the size of the tufting base is relatively small, but as shown in Figure 31, a variety of embodiments can be used for a toothbrush where monofilaments with a rectangular cross section are implanted in elliptic tufting holes using the same arrangement of tufting holes as in the above-mentioned example.

The subject of the present example is a toothbrush where the tufting holes are elliptic, but tufting holes that are almost elliptic are included in the concept of almost elliptic defined by the invention of the present

application, and in addition to elliptic tufting hole 110 shown in Figure 33, tufting hole 100' that is almost elliptic shown in Figure 34 is included in the concept of almost elliptic.

The present example differs from the above-mentioned example in that in contrast to the fact that monofilaments with a round cross section are implanted in rectangular tufting hole 100", as shown in Figure 32, in the above-mentioned example, monofilaments with a rectangular cross section are implanted in a tufting hole that is inclined and has an elliptic or oval-shaped opening in the present example.

It is possible to improve tight-space cleaning performance even further and to all but eliminate cracking of the tufting base and improve toothbrush durability by using elliptic tufting holes and making the lengthwise direction of the tufting holes along the direction of handle length, that is making the lengthwise direction of the tufting holes the same or almost the same as the direction of handle length.

The reason why tight-space cleaning performance is improved is that when the tufting holes are elliptic and the lengthwise direction of the tufting holes is the same as the direction of handle length, both ends of the tufts that have been implanted in the tufting holes are streamlined in the direction of handle length and are

narrow and therefore, insertion into tight spaces is improved.

Moreover, there is no cracking of the tufting base and durability of the toothbrush is improved for the following reasons:

The toothbrush is molded using an injection molding and the tufting base in which the tufting holes have been formed is molded by filling molten synthetic resin into a cavity for molding the tufting base in the mold. Pins for forming the tufting holes are planted in the cavity and the molten synthetic resin flows around these pins for forming the tufting holes. Once the synthetic resin has cured, the mold is opened and the pins for molding the tufting holes are at the same time removed to form the tufting holes. Tufting holes are molded in this way. Pins that correspond to the shape of the tufting holes to be made can be used for the pin for forming the tufting holes, but the state in which the molten synthetic resin will flow around the pin varies with the shape of this pin used to form the tufting holes and this will affect cracking of the tufting base. For instance, when tufting holes that are rectangular in shape are used, pins 200 for forming tufting holes will have angles 201, as shown in Figure 35. Nevertheless, since it does have angles 201, the molten synthetic resin that is supposed to flow around angle 201 and into space 205 between this pin and adjacent pin 210 for forming

tufting holes will not flow exactly along the surface of pin 200 for molding tufting holes and as a result, the resin will not firmly bond back together when it flows around pin 200 for molding the tufting holes and then merges again. Consequently, the part where the resin is not thoroughly bonded together will easily crack. Since an anchor will be driven into the part where the resin is not firmly bonded together when an anchor is driven parallel in the lengthwise direction of the tufting holes, cracks will form even more easily. This is particularly obvious when the center line in the direction of width of adjacent tufting holes overlaps a line extending on the center line in the direction of width of the tufting holes as shown in Figure 35, that is, when the space between adjacent tufting holes is narrow.

In contrast to this, as shown in Figure 36, when the tufting holes are elliptic, the molten synthetic resin can smoothly flow around the curved surface of the oval shape of pin 300 for forming tufting holes and the molten synthetic resin can firmly bond back together when it flows around pin 300 for molding the tufting holes and merges again. As a result, the part where the resin bonds back together after splitting to go around the pin is sufficiently strong. Consequently, the chance that the tufting base will crack can be reduced dramatically and a toothbrush can be obtained that shows no cracking and

excellent durability, even if the anchor is driven in parallel to the direction of length of the tufting holes.

By means of the present example, the direction of length of the rectangular surface was made the same as the direction of handle length using monofilaments with a rectangular cross section and therefore, when the method of brushing by moving the handle back and forth in its lengthwise direction is used, the resiliency of the tuft is very high. Moreover, since the tuft on either side in the direction of width of the tufting base is inclined toward the inside, there is no separation of monofilaments during brushing and resiliency of the monofilaments is efficiently realized.

The inventors performed studies on how resiliency during brushing is affected by inclination of the tufting holes and by different cross sections of monofilaments in toothbrushes with elliptic tufting holes. The experiments were performed using Trial Product 2 of this example and Comparative Products C, D and E in which monofilaments with a round cross section were implanted in order to compare resiliency of the monofilaments of these toothbrushes. Of the toothbrushes used in the study, the shape and arrangement of the tufting holes of all but Comparative Example 3 were the same as shown by Figure 30, and the number of tufting holes used for Comparative Product C was 17. The tufting holes of Comparative Product C were

vertical holes with a round cross section having a diameter of 0.190 mm, the tufting holes of Comparative Product D were vertical holes with a round cross section having a diameter of 0.160 mm, the tufting holes of Comparative Product E were vertical tufting holes with a rectangular cross section of 0.254 mm x 0.162 mm, and the tufting holes of Trial Product 2 of the present example were tufting holes with a rectangular cross section of 0.254 mm x 0.162 mm. Four tufting holes placed on the outside in the direction of tufting base width were inclined inside at 3°, as shown by Figure 30. Resiliency was measured as "resiliency per surface area in the direction of handle length" and "resiliency per unit surface area in the direction of handle width. These two types of resiliency were compared and are represented as the "ratio of resiliency in the direction of length and in the direction of width." Resiliency of the monofilaments was calculated by international standards (ISO). The reaction force that was produced when resistance was applied to 1/3 the length of the monofilament for elastic deformation was measured and is represented in units newton (N). The results are shown in Table 4.

Table 4

	Monofilament cross sectional shape	Cross sectional specifications (mm)	State of inclination of tufting holes	Number of tufting holes	Resiliency per unit surface area in direction of handle length	Resiliency per unit surface area in direction of handle width	Comparison of resiliency in direction of length and direction of width
Comparative example C	Round	$\phi=0.190$	Perpendicular to tufting surface	17	1.59	2.01	79:100
Comparative example D	Round	$\phi=0.160$	Perpendicular to tufting surface	6	1.54	1.66	93:100
Comparative example E	Rectangular	0.254×0.162	Perpendicular to tufting surface	6	2.34	1.70	138:100
Trial product 2	Rectangular	0.254×0.162	Only 4 holes inclined 3°	6	2.76	1.69	163:100

As is clear from Table 4, when compared to Comparative Products C, D and E, resiliency per unit surface area in the direction of handle length is strong with Trial Product 2, the toothbrush of the present invention, and it was confirmed that resiliency in the direction of handle length was greater than that in the direction of width. Thus, it was shown that the toothbrush of the present invention, Trial Product 2, is ideal for brushing methods where the toothbrush is moved in the direction of handle length, typically the scrubbing method, and that the toothbrush of the present invention provides excellent cleaning effects. Moreover, as is clear from the fact that Trial Product 2 of the present invention provides less resiliency per unit surface area in the direction of handle width than did Comparative Products C, D and E, there is not an absolute increase in resiliency of the toothbrush of Trial Product 2 in comparison to Comparative Products C, D, and E, but instead, an increase in resiliency in the direction of handle length can be expected because distribution of resiliency that is applied in the direction of handle length and of handle width is changed and as a result, cleaning effects are improved without increasing irritation of the tissue of the oral cavity. Thus, it was shown that the toothbrush of the present example is a toothbrush that is ideal for the scrubbing method.

Moreover, since monofilaments were implanted in tufting holes with an almost elliptic shape extending in the direction of handle length of the toothbrush of Trial Product 2 (this point was the same in Comparative Examples C, D and E, both ends of the tufts in the direction of handle length formed a peak that curved streamlined and the width of this peak was narrow. Teeth can be touched using this curved narrow peak and therefore, initial contact resistance when the toothbrush touches the teeth can be minimized. As a result, the monofilaments at both ends of the tufts in the direction of handle length can be easily inserted into interdental space when teeth are brushed by the scrubbing method, and coupled with the fact that resiliency of the monofilaments can be increased, cleaning effects are improved even further.

Moreover, since the toothbrush of the present example uses tufting holes that are elliptic, cracking of the parts between adjacent holes in the tufting base will hardly occur and there is therefore no fear of cracking, even if an anchor is driven into this part. Consequently, as shown in Figure 30, by means of the toothbrush of the present example, an anchor can be driven into the tufting hole along the lengthwise direction of the tufting hole at the center of the tufting hole in its direction of width extending along the direction of handle length and therefore, tufts can be implanted symmetrically, to the

left and right of the center in the direction of width of the tufting hole, as shown in Figure 33, making it possible to realize uniform density of monofilaments on both sides of the anchor. Consequently, all of the monofilaments can be brought to face almost perpendicular to the tufting surface to obtain a good raised effect and a beautiful toothbrush.

The inventors studies how the raised effect (appearance) of the monofilaments is affected by a difference in the tufting hole shape and the cross sectional shape of the monofilaments and a difference in the direction in which the anchor is driven into the tufting hole and evaluated the raised effect (appearance). The results are shown in Table 5. a Through f in Table 5 are conventional toothbrushes, g is a toothbrush of the present example, and h is an example where the shape of the tufting hole is the same as in above-mentioned g, but the anchor is inclined and driven into the hole at an inclination of 15° to the direction of handle length.

Table 5

	Shape of tufting hole	Cross sectional shape of monofilament	Direction in which anchor is driven into tufting hole	Evaluation of raised effect
a	Round	Round	Parallel to direction of handle length	○
b	Round	Round	Inclined 15° to direction of handle length	○
c	Round	Rectangular	Parallel to direction of handle length	○
d	Round	Rectangular	Inclined 15° to direction of handle length	○
e	Elliptic	Round	Parallel to direction of handle length	○
f	Elliptic	Round	Inclined 15° to direction of handle length	△
g	Elliptic	Rectangular	Parallel to direction of handle length (including ± 10°)	○
h	Elliptic	Rectangular	Inclined 15° to direction of handle length	×

Evaluation of raised effect with implanting

○ = no problems

△ = somewhat poor raised effect

× = poor raised effect

As is clear from Table 5, when the tufting holes are round, the appearance of the toothbrush is unaffected by the cross sectional shape of the monofilaments or the direction in which the anchor is driven into the tufting holes, and the appearance is good. Moreover, it is clear that the raised effect (appearance) of the toothbrush is good, even if tufts of monofilaments with a round cross section are driven into elliptic tufting holes parallel to the direction of length of the handle.

On the other hand, although the raised effect is good when the anchor is driven into a elliptic tufting hole along the direction of length of the handle, the raised effect is somewhat inferior if the anchor is driven into the hole so that it intersects the direction of length of the handle at an angle of 15°. Moreover, when monofilaments with a rectangular cross section were implanted into elliptic tufting holes, the raised appearance was poor if the anchor was driven into the hole intersecting the lengthwise direction of the handle, but the raised effect was good and appearance was good with the toothbrush of the present example where the anchor was driven parallel to the direction of handle length.

The toothbrush of the present invention can provide a difference in tuft resiliency in the longitudinal and latitudinal directions of the tufting holes because the tufting holes are almost elliptic or almost rectangular and therefore, cleaning effects can be improved by adjusting the direction along the long side of the holes. Moreover, since the tufting holes are inclined toward the tufting surface, brushing power in a specific direction can be improved by controlling the direction of inclination. In addition, since the tufting holes themselves are inclined, the above-mentioned inclined position will not collapse and stable brushing force can be obtained over long periods of time, even with repeated application of pressure with brushing. Moreover, a toothbrush with both tight-space cleaning performance for interdental spaces, the cervical portion of the tooth and occlusal surfaces and smooth-surface cleaning performance for a tooth surface can be obtained by designing the lengthwise direction of the tufting holes and the direction of inclination of the tufts to match the brushing direction. In particular, when the tufting holes are almost elliptic holes, the contact resistance when the tufts first touch the tooth can be minimized because the tufts are streamlined, and the narrow monofilaments at both ends in the lengthwise direction of the tufting holes can be easily introduced to interdental space, improving cleaning effects even further.

When the lengthwise direction of almost elliptic or almost rectangular tufting holes is alone the direction of handle length, the resiliency of monofilaments in the brushing direction can be increased and excellent cleaning results can be realized when teeth are brushed by the scrubbing or Bass method with mainly back and forth movement in the direction of handle length.

When there is at least one group of tufting holes that are inclined to the inside and form a pair, the tufts implanted in these tufting holes will support one another and reinforce tuft stiffness. Moreover, their end portions converge and as a result, a toothbrush can be presented with which the tufts can be inserted into tight spaces, including interdental spaces, the cervical portion of the tooth, and the occlusal surface, and the food sediment and plaque that has accumulated in these sites can be forcibly removed.

By designing inclination to a vertical direction of the inclined holes within a range of 2 to 10°, a toothbrush is obtained with which optimum pressure can be applied to interdental spaces, the cervical portion of the tooth and occlusal surfaces, and the degree to which the end portions of the tufts converge is optimized and there is excellent insertion into interdental space, etc.

When the monofilaments comprising the tufts that are to be implanted in the tufting holes have a rectangular

cross section and the direction of the long side of this cross sectional shape is along the lengthwise direction of the tufting holes, resiliency of the monofilaments in the lengthwise direction of the tufting holes can be increased and toothbrush cleaning power can be improved even further. Moreover, since the cross sectional area for realizing the same resiliency is small in comparison to monofilaments with a round cross section, irritation of oral cavity tissues is also minimized.

When converging blocks are made when a pair of tufts that face one another support each other and a plurality of this type of converging block is made, the tufting part will have excellent tight-space cleaning capability and there will be a plurality of places where tuft stiffness is realized, resulting in more efficient brushing.

When the end portion of each tuft is worked to a V-shape, tight-space cleaning performance is improved even further. In particular, when a V-shape is made so that an inclined face is formed to the front and the back where the direction in which the adjacent tufts support one another is intersected, tight-space cleaning performance in the direction of handle length and tight-space cleaning performance in the direction of handle width are both improved.

By placing converging blocks at least in front and behind the direction of handle length and positioning the

next row of converging blocks behind the space that is formed between converging blocks in the front row in the direction of handle length, the part of the tooth that has been missed by the front row of converging blocks will be brushed by the next row of converging blocks and as a result, an entire smooth surface, such as a tooth surface, can be brushed by the end portion of a converging block that is very stiff and has excellent brushing power.

When an anchor that is used to drive the tufts into the tufting holes is driven into the tufting hole so that it is parallel to the long side or the short side of the tufting hole and it divides the opening area of the tufting hole into two equal parts, the filaments can be filled into the hole uniformly and as a result, none of the tufts will be lost, which ends in loose packing density, and the appearance of the tufting part will be beautiful.

When the centers of the tufting holes are such that they are not lined up on one straight line in the direction of handle length, cracking can be prevented. Consequently, the tufting holes can be big and adjacent tufting holes can be close to one another.

When tufting holes account for 10 to 30 mm in the direction of handle length and 5 to 15 mm in the direction of handle width, a smooth surface can be efficiently brushed with no reduction in maneuverability inside the oral cavity.

When the tufting holes are almost rectangular and the short side of these almost rectangular tufting holes is designed to dimensions of 0.8 to 2.0 mm, while the long side is designed to dimensions of 1.5 to 5.0 mm, the size of the end portion of the converged part that is formed by the tufts supporting one another is ideal in terms of realizing both smooth-surface and tight-space cleaning performance.

When the angle of inclination of the tufts comprising the converging blocks is within a range of 2 to 10° and the distance between the tufts [at their base] is 0.2 to 4.0 mm, as previously explained, collapse of the converged shape with long-term use can be prevented.

Moreover, when there are 5 rows of tufts in the lengthwise direction of the tufting base, with Rows 1 and 5 forming one converging block in the center in the direction of width of the tufting base, Rows 2 and 4 forming 2 converging blocks on either side sandwiching the center in the direction of width of the tufting base, and Row 3 forming one converging block at the center in the direction of width of the converging block, and there is 1 independent tuft, each inclined so that it is in the same direction as the tufts that form the above-mentioned converging blocks, but its end portion does not touch the converging blocks, to the outside of the above-mentioned converging blocks, the front surface in the forward

direction of the site to be cleaned is brushed by Row 1 of converging blocks, these tufts being run up on the tooth, and then the tufts on both sides in the direction of width comprising Row 2 are pushed to ether side of the tooth and both sides are brushed by the tufts in Row 2. Then this front surface is brought into contact with Row 3 and this same state is repeated moving from Row 3 to Row 1. Thus, a toothbrush with strong cleaning performance is obtained.